ENGINEERING REPORT

for

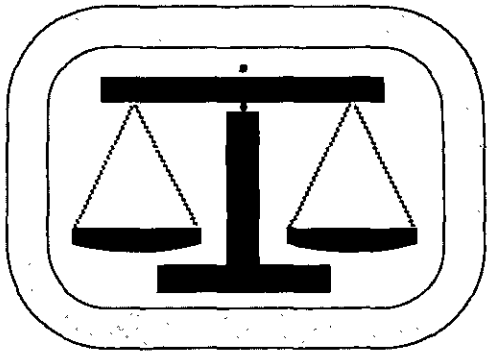
Contract DACW-33-81-C0030

Work Order Number 10

Piezometer Installation

West Hill Flood Control Dam

Uxbridge, Massachusetts



BRIGGS

BRIGGS

164 Washington Street, Norwell, MA 02061 ▷ Telephone (617) 773-2780

20 October, 1981

JBF

Mr. Joe B. Fryar
Chief Engineering Division
New England Division
U.S. ARMY CORPS OF ENGINEERS
424 Trapelo Road
Waltham, MA 02254

RE: Contract DACW 33-81-C-0030
Work Order No. 10

Dear Mr. Fryar:

In accordance with Work Order No. 10 dated 25 June 1981, we enclose one (1) copy of our Engineering Report for the piezometer installation at the West Hill Flood Control Dam, Uxbridge, MA. Two (2) additional copies have been delivered under separate cover to your Geotechnical Branch. If you have any questions or comments, please do not hesitate to call.

Very truly yours,

David S. Campbell, P.E.
Executive Vice President

DSC/ja
Enclosure

RECEIVED
OCT 28 1981
Geotech. Engrg. Br.

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TABLE OF CONTENTS

1.0 GENERAL

1.1 Authorization

The work reported herein was performed under contract DACW 33-81-C-0030, Work Order No. 10 dated 25 June 1981. The authority for this project is derived from the NED Dam Assurance Program, Public Law 96-367.

1.2 Project Site

The site is located at West Hill Dam, Uxbridge, MA. It is located on the downstream side of the main embankment. (See Plates M37 and M37a.)

1.3 Purpose

Sand boils were discovered near the downstream toe of the dam in January of 1979. Results of geotechnical investigations showed that these boils were caused by the build-up of seepage pressures in the pervious foundation soils which were covered with a thin capping of less pervious surficial soils. In order to relieve these pressures, a foundation toe drain was constructed in the summer of 1979. Four piezometers (PZ-1 thru PZ-4) were installed near the toe drain in January 1980 so that the foundation seepage pressures could be measured and the performance of the toe drain evaluated during future flood control operations.

The purpose of this work order is to install four Casagrande type piezometers at the locations shown on Figure 1. This is to augment the present piezometer system in order to be able to develop a phreatic line of the seepage through the dam and provide data for use in evaluating the performance of the repair work.

1.4 Scope of the Investigation

The work performed under this work order consisted of:

a. Providing and installing four Casagrande type piezometers.

b. Performing a falling head permeability test on each of the newly installed piezometers. (Appendix B)

c. Surveying in the exact locations and top elevations of the four existing and four new piezometers. (Appendix C)

d. Furnishing Shift Reports (Appendix A)

e. Furnishing an Engineer's Report.

f. Certifying Quality Assurance by a Registered Professional Engineer.

2.0 SUBSURFACE INVESTIGATION

2.1 Equipment

The equipment and type of tools used are described below.

a. Core Drill: The core drill used was a modern, hydraulically driven rotary head unit manufactured by Acker Drill Co. The core drill was used to install the two piezometers located on the crest of the embankment.

b. Portable Rig: The portable rig used consisted of a tripod and cathead driven by a 9 HP Briggs and Stratton engine. The portable rig was used to install the two piezometers located on the downstream slope of the embankment.

c. Drive Hammers: Drive hammers for advancing the casing weighed approximately 300 lbs.

d. Casing and Rods: NW flush joint casing was used to keep the borehole open. AW drill rods were used for washing out the casing.

e. Water Level Indicator: The water level indicator consisted of a "Radio Shack" ohmmeter, 50 ft of plastic coated copper wire graduated in 5 ft increments and a sensing tip manufactured by Soiltest, Inc.

2.2 Materials

The materials used are described below.

a. Piezometers: The piezometers consist of 1 1/2" I.D. by 24" long porous, high density polyethylene tube as manufactured by Piezometer Research and Development of Stamford, Connecticut. The riser pipe is 3/4" Sch 80 PVC pipe.

b. Sand: Ottawa silica sand was placed around the piezometer tube and below the bentonite seal. Clean medium to fine sand was placed from the top of the bentonite seal to the ground surface.

c. Bentonite Pellets: The bentonite consisted of 1/2" pellets as manufactured by Roctest of Plattsburgh, New York.

2.3 Procedures

The piezometers were installed in accordance with the following procedures.

a. The borehole for PZ-7, the first piezometer installed, was advanced by driving NX flush joint casing to a depth of 10 ft below grade, then washing 10 ft beyond the bottom of the casing and finally driving the casing into the previously washed interval. This procedure was followed until the required depth was attained. Due to the difficulty in driving the casing, this procedure was modified for the remaining piezometers. The boreholes were advanced to the required depth by washing ahead only about 7 feet below the bottom of the casing and then driving a section of casing 5 ft into the previously washed interval. After reaching the required depth, the borehole was flushed clean.

b. Once the hole was flushed cleaned the piezometer and riser pipe were installed in the borehole. The piezometer tip was backfilled with Ottawa 20-30 sand and a bentonite seal placed 3 feet above the top of the piezometer. The hole was then backfilled with clean sand as the casing was removed.

c. After the casing was removed, a falling head permeability test was conducted to verify that each piezometer was functioning properly. The falling head test was performed by filling the standpipe with clean water until the water overflowed the pipe. The water level was maintained at the top of the standpipe for approximately 1 minute by adding water as necessary. The water level was then allowed to drop with water levels readings taken as shown on the falling head permability test results in Appendix B. Finally, the protective cover was installed. The protective cover consisted of a 6 inches I.D. by 36 inch pipe of steel pipe with a screw cap. The ground was excavated around the piezometer such that the top of the protective cover was about 9 to 12 inches above the surrounding ground. The steel pipe was installed and the excavaton backfilled with concrete.

2.4 Records

NED Forms 58 and 58A, dated March 1971 entitled "Field Log of Test Boring" were used to record pertinent piezometer installation data. All logs include the following:

a. Site location, piezometer number and location.

b. Make and model designation of the drilling equipment.

c. Type of drilling operation by depth.

d. Elevation of top of riser pipe and bottom of piezometer.

e. Elevation of top and bottom of borehole

f. Results of falling head permeability test.

2.5 Laboratory Testing

No laboratory tests were requested as part of this work order.

3.0 SUBSURFACE CONDITIONS

3.1 Soils

Our knowledge of the subsurface conditions at the site is based on the results of the field work described in Section 2.0.

The soils encountered in the washings consist of approximately three feet of brown, compact gravelly sand and sandy gravel, underlain by gray, dense, silty medium to fine sand (random fill). The natural material is a brown, compact medium to fine sand. The materials and their thicknesses correspond with the cross-section provided as part of this work order.(See Plate M37a)

3.2 Groundwater

Groundwater level readings were taken as part of the falling head permeability test performed on the newly installed piezometers. The readings indicate that the groundwater level varies from el 235 in Piezometers PZ-5, PZ-7 and PZ-8A to el 234 in Piezometer PZ-6.

4.0 SURVEY

4.1 Equipment

The surveying equipment used to locate the piezometer was a 200 ft steel tape, a 10 ft stadia rod, a levelling gun and a transit.

4.2 Procedures

The elevation of each piezometers was established by differential levelling using the benchmark located at Sta 36+12.61 as control. The location of each piezometer was established by tape and transit using the benchmark at Sta 36+12.61 as control.

4.3 Results

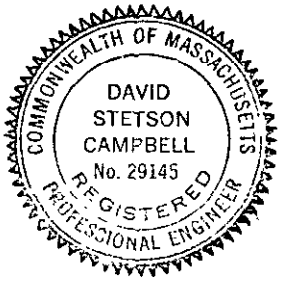
Results of the field survey are provided in the survey field notes which are included as Appendix C to this report. As shown on Figure 1 Piezometers PZ-5 and PZ-6 were located at Sta 34+05.61 and Piezometers PZ-7 and PZ-8A at Sta 36+05.61, while the work order stated that they should be located at 34+00 and 36+00, respectively. This discrepancy was due to an error by the surveyor in taping the distances from the control point i.e., the benchmark at Sta 36+12.61 to the piezometer locations. The error was discovered after the piezometers were installed.

5.0 QUALITY ASSURANCE CERTIFICATION

I hereby certify that the above mentioned materials, equipment and procedures were used to locate and install the piezometers described in this report. I also certify that the work (piezometer installation and surveying) was performed in a professional manner and meets the requirements set forth in the Contract and this Work Order.

Certified 22 September 1981

David S. Campbell, P.E.
Executive Vice President



CORPS OF ENGINEERS

U.S. ARMY

℄ DIKE "C"

℄ RAMP

ROAD BARRIER

DRAINAGE DITCH

℄ DIKE "B"

PILE NO 1

PILE NO 2

PILE NO 3

PILE NO 4

LOG BOOM

NOTE: Clear 10 feet each side of log boom

CEDAR SWAMP

SWAMP

SPOIL AREA

Approx. limit of rock cut

℄ SPILLWAY

℄ INTAKE CHANNEL

4' thick impervious SPOIL blanket seeded

RIVER

FLOW

℄ DIKE "A"

FLAG POLE

LATRINE

ROAD BARRIER

PARKING AREA

GAGE BUILDING

N 87°-50'-00"E

SPILLWAY BRIDGE

Seeded impervious SPOIL blanket 3' thick above EL 260.0

Limit of SPOIL blanket

4' thick impervious blanket seeded

EAST

WEST

N 78°-55'-00"E

DAM

TURNAROUND

BCGM 30" Culvert

BCGM 48" Culvert

2' Rock Fill on 1' Gravel Fill on 2' thick Fill above El 253.0

℄ OUTLET CHANNEL

BOULDERS

℄ ACCESS ROAD

ROCK SPOIL AREA

PROJECT IDENTICATION SIGN (For Details see Sheet 38)

HARTFORD

ROAD

SWAMP

RIVER

SCALE IN FEET

100' 0 100'

LEGEND

- SWAMP
- EXISTING GRAVEL OR DIRT ROADS
- PAVED ROADS
- CONTOUR INTERVALS 2'

NOTES

1. CONTOUR INTERVAL 2 FEET
2. ELEV. REFER TO MEAN SEA LEVEL
3. GRID SYSTEM BASED ON MASS. STATE PLANE COORDINATES

LEGEND

PZ Piezometers

( ) Elevation Top of Riser Pipe

PLAN OF DIKE "D"

SCALE 1" = 100'

℄ WOLF HILL ROAD

UTILITY POLE LINE

N 404,250
E 568,594

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
DIVISION ENGINEER

BLACKSTONE RIVER FLOOD CONTROL

WEST HILL DAM
GENERAL PLAN

WEST RIVER, MASSACHUSETTS

DRAWING NO. 958

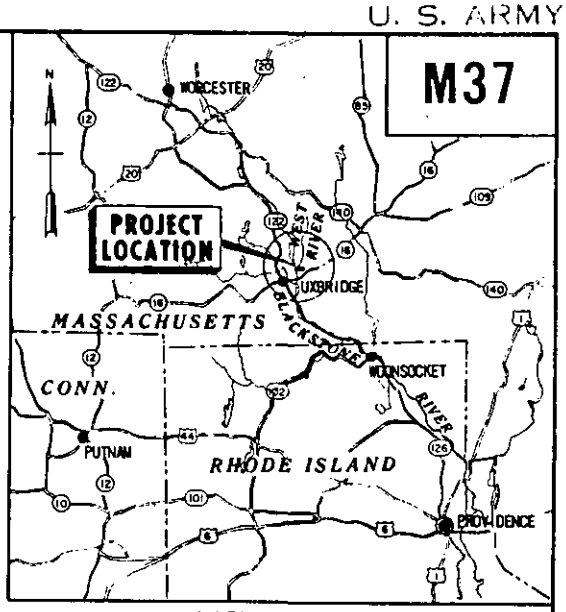
BETTMO

FIGURE 1

CORPS OF ENGINEERS

U. S. ARMY

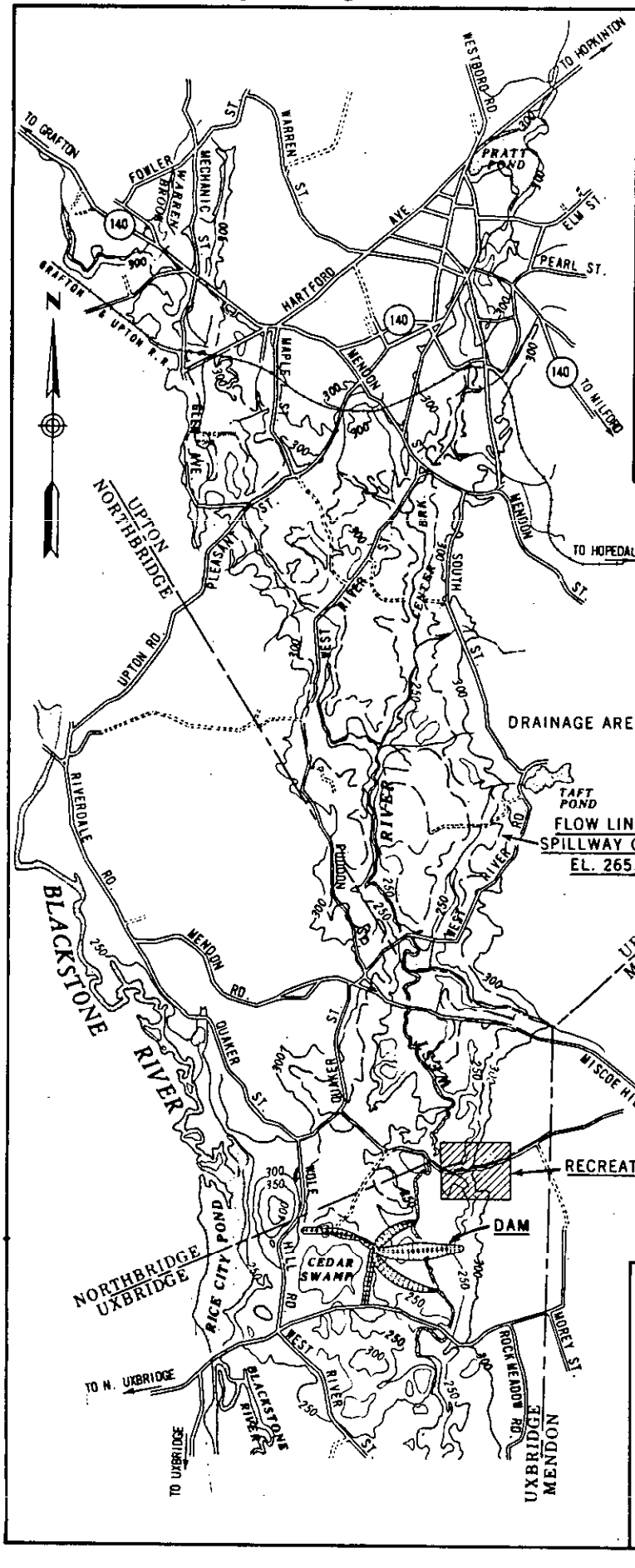
M37



VICINITY MAP

SCALE IN MILES

5 0 5 10 15



BLACKSTONE RIVER BASIN

WEST HILL DAM

RESERVOIR MAP

30 SEPTEMBER 1976

WEST RIVER MASSACHUSETTS

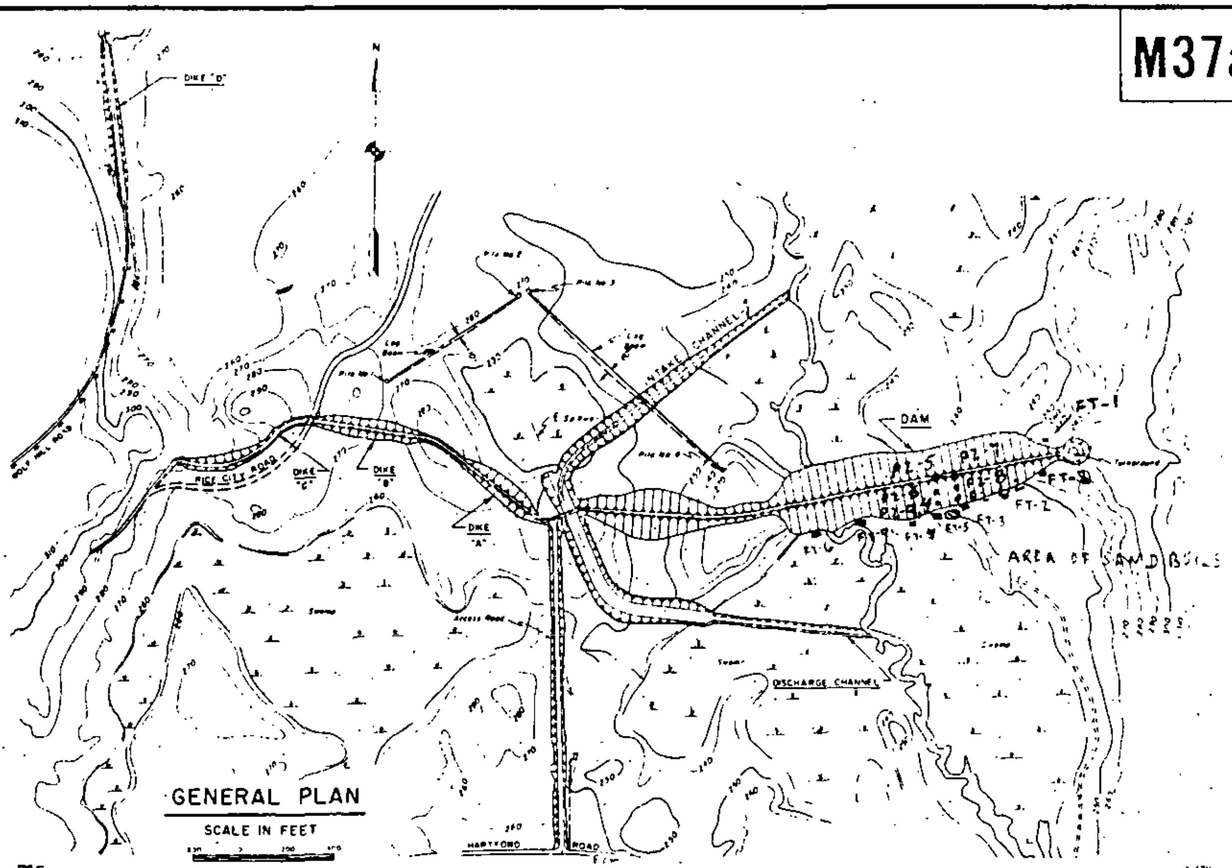
SCALE IN FEET

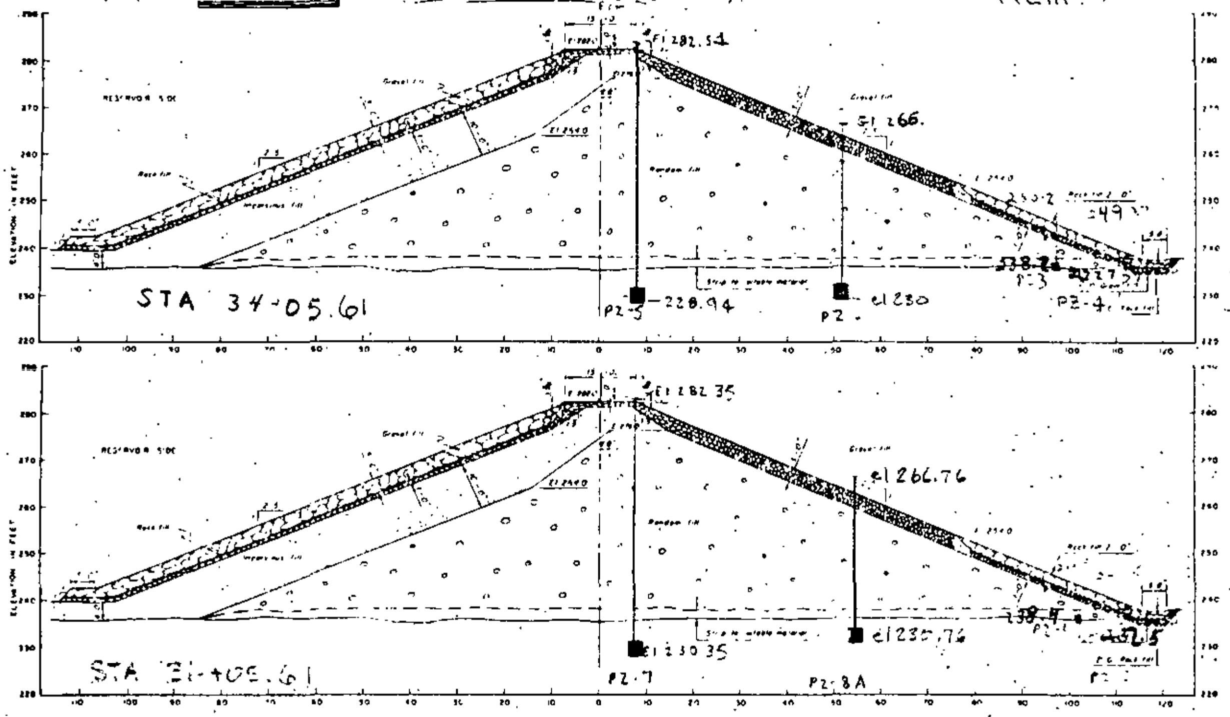
2000 0 2000 4000

NEW ENGLAND DIVISION WALTHAM, MASS

CORPS OF ENGINEERS U. S. ARMY

M37a





TYPICAL SECTIONS

SCALE AS SHOWN

BLACKSTONE RIVER FLOOD CONTROL

WEST HILL DAM

PLAN & SECTIONS

WEST RIVER, MASSACHUSETTS

30 SEPTEMBER 1976

NEW ENGLAND DIVISION WALTHAM, MASS.

BRIGGS ENGINEERING CORPORATION

WEEKLY SAFETY MEETING

TO: Safety Office, NED

FROM: Field Engineer — Date held 3 August 1981

THRU: Project Engineer — Time 0900hrs

Weekly safety meeting was held this date for the following personnel:
Contract No. DACW 33-81-C-0030 Personnel present: C. Reil
Work Order No. 10 J. Mullen
Conducted By: N. Lanney

1. Subjects discussed (Note, delete, or add):

- x Individual Protective Equipment -
  Prevention of Falls -
- x Safe Lifting Techniques -
  Emergency Communications -
  Fire Prevention -
  Sanitation, First Aid -
- x Tripping Hazards - trash, hose, nails in lumber -
  Staging, Ladders, Concrete Forms -
  Hand Tools -
  Portable Power Tools -
  Woodworking Machinery -
- x Equipment Maintenance (Zero defects) -
- x Hoisting Equipment -
- x Ropes, Hooks, Chains and Slings -
  Electrical Grounding, Temporary Wiring -
  Lockouts for safe clearance procedures -
  Electrical, pressure, moving parts -
  Welding -
  Excavations -
- x Loose Rock and Steep Slopes -
  Explosives -
  Water Safety -
  Other -

Prepared by: Nicholas Lanney
Field Engineer

2. Exposure:
For the period of 3 August to 7 August 1981, covering 3 men for 40.0 man-hours per man for a total of 120 man-hours.

Signature: Nicholas Lanney
Project Engineer

3. Forwarded: NED, Waltham, MA

BRIGGS ENGINEERING CORPORATION

WEEKLY SAFETY MEETING

TO: Safety Office, NED

FROM: Field Engineer Date held 10 August 1981

THRU: Project Engineer Time 0730hrs

Weekly safety meeting was held this date for the following personnel:
Contract No. DACW 33-81-C-0030 Personnel present: C. Reil
Work Order No. 10 J. Mullen
Conducted By: R. Bukoski

1. Subjects discussed (Note, delete, or add):

x Individual Protective Equipment -
x Prevention of Falls -
x Safe Lifting Techniques -
x Emergency Communications -
Fire Prevention -
Sanitation, First Aid -
x Tripping Hazards - trash, hose, nails in lumber -
Staging, Ladders, Concrete Forms -
Hand Tools -
Portable Power Tools -
Woodworking Machinery -
x Equipment Maintenance (Zero defects) -
x Hoisting Equipment -
x Ropes, Hooks, Chains and Slings -
Electrical Grounding, Temporary Wiring -
Lockouts for safe clearance procedures -
Electrical, pressure, moving parts -
Welding -
Excavations -
x Loose Rock and Steep Slopes -
Explosives -
Water Safety -
Other - Brush Clearing Equipment Safety

Prepared by: Ronald F. Bukoski
Field Engineer

2. Exposure:
For the period of 10 August to 11 August 1981, covering 3 men for 15.5 man-hours per man for a total of 46.5 man-hours.

Signature: Nicholas A. Lowney
Project Engineer

3. Forwarded: NED, Waltham, MA

APPENDIX A

Shift Reports

Briggs Engineering Co.

Shift Report

DATE: 8-3-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Nick Lanney

TIME: 0900 - 1700 COMMENTS

This report summarizes the first day of drilling and piezometer installation at the West Hill Flood Control Dam in Uxbridge, MA. Arrived at the site at 0900 and met with John Finnerty, the dam superintendent. A safety meeting was conducted, then the drill rig was set up over Piezometer PZ-7. The casing was advanced to the depth of 35.0 ft. It was very difficult to advance the casing due to the dense soil conditions. Once the casing was driven to a depth of 10 ft below ground surface, the drilling procedure was to wash ahead about 10 ft below the bottom of the casing with an open-end A-rod, then drive the casing 10 ft. As would be expected the first 5 ft was easier to drive than the second five. Wash water samples indicated that the dam material is a gray silty medium to fine sand.

Summary: Drilling 35.0 ft

Briggs Engineering Co.

Shift Report

DATE: 8-4-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Ronald F. Bukoski

TIME: 0740 - 1600 COMMENTS

This report summarizes the second day of drilling and piezometer installation at the West Hill Flood Control Dam. Prior to departure to the site a safety briefing was conducted by Nick Lanney. The drilling continued in Piezometer PZ-7 from 35 to 53 ft. The piezometer was installed at a depth of 52.0 ft. Casing removal was very difficult. Only 4 feet were removed in 2 hours.

Summary:		
	Drilling	18.0 ft
	Piezometers Installed	1

Briggs Engineering Co.

Shift Report

DATE: 8-5-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Nick Lanney

TIME: 0745 -1545 COMMENTS

This report summarizes the third day of drilling and piezometer installation at the West Hill Flood Control Dam. The casing was removed for PZ-7 and the protective cover installed. A falling head permeability test was then sucessfully conducted. Once the test was completed the rig was moved and set up on PZ-5. The casing was driven to 40.0 ft below grade. It was not as difficult to advance the casing for PZ-5 as for PZ-7. The hole was advanced by washing about 7 ft below of bottom of the casing, then driving the casing 5 feet into the previously washed zone.

Summary:	Drilling	40.0 ft
	Moving/Standby Time	45 min.

Briggs Engineering Co.

Shift Report

DATE: 8-6-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Nick Lanney

TIME: 0745 -1545

COMMENTS

This report summarizes the fourth day of drilling and piezometer installation at the West Hill Dam. The borehole for PZ-5 was advanced to a depth of 53 ft below grade. The piezometer was installed, the hole backfilled with Ottawa sand then bentonite, then clean sand backfill. The casing was removed as required. The falling head permeability test was run and successfully completed. The portable rig was then set up on PZ-6 and the casing advanced to a depth of 10.0 ft. The protective cover was installed on PZ-5 and the Acker rig dismantled and taken off-site.

Summary:		
	Drilling	23.0 ft
	Piezometers Installated	1
	Moving/Standby Time	150 min.

Briggs Engineering Co.

Shift Report

DATE: 8-7-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Nick Lanney

TIME: 0745 -1545

COMMENTS

This report summarizes the fifth day of drilling and piezometer installation at the West Hill Dam. The borehole for PZ-6 was advanced from 10.0 to 35.0 ft below grade. The piezometer was installed and the casing removed. Subsequently, the falling head permeability test was conducted, followed by installation of the protective cover. The portable rig was demobilized and the work area regraded to its original condition.

Summary:		
	Drilling	25.0 ft
	Piezometers Installed	1
	Moving/Standby Time	150 min.

Briggs Engineering Co.

Shift Report

DATE: 8-10-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Ronald F. Bukoski

TIME: 0750 - 1550 COMMENTS

This report summarizes the sixth day of drilling and piezometer installation at the West Hill Dam. The portable rig was set up at the location of PZ-8. A boulder was encountered at a depth of 16 ft. The boulder could not be pushed aside or broken. An attempt was made to contact Roger Poisson of the Army Corps by telephone to discuss the relocation of the boring. We were informed that he would be on site shortly to inspect the work being performed; in fact he had already arrived with John Hart.

Following a brief discussion with Roger Poisson and John Hart, a decision was made to move the hole approximately 3.5 ft toward the top of the dam. Following the repositioning of the portable drilling rig, "AW" rods were driven to 20 ft to assure that the boulder encountered in the previous location would not obstruct the drilling in this location. Following the probing with "AW" rods the casing was advanced to a depth of 15 ft.

Summary:		
	Drilling	31.0 ft
	Moving/Standby Time	145.0 min

Briggs Engineering Co.

Shift Report

DATE: 8-11-81
SHIFT NO: [1]
PROJECT: West Hill Dam
INSPECTOR: Ronald F. Bukoski

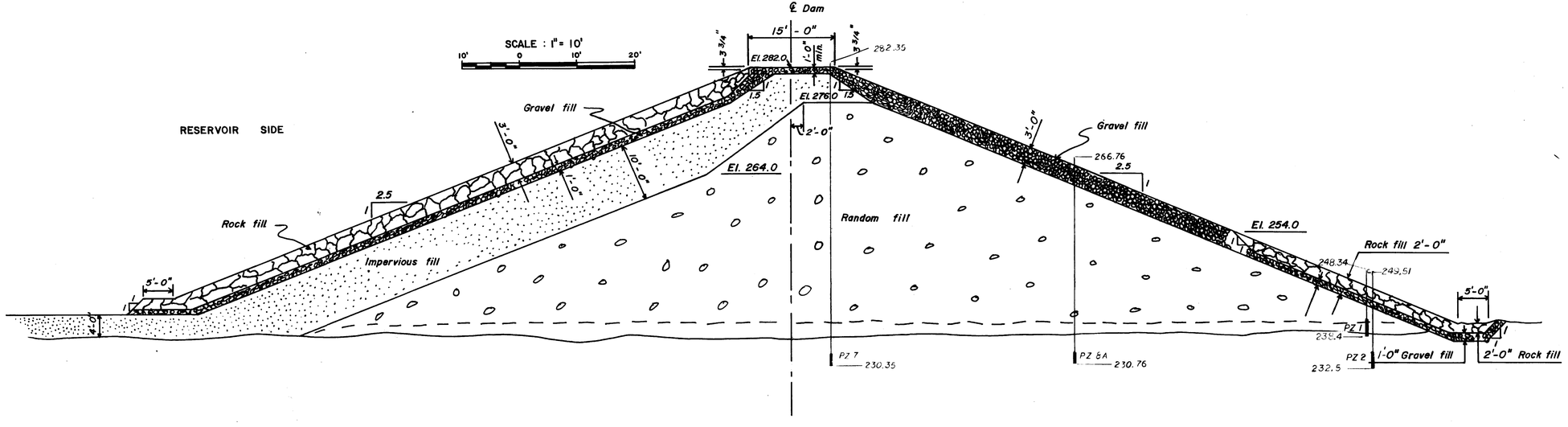
TIME: 0740 - 1510 COMMENTS

This report summarizes the seventh and final day of work at the West Hill Dam. Drilling was continued in Boring PZ-8A from 15 ft. The casing was advanced to a maximum depth of 33.0 ft. The hole was washed to a maximum depth of 36.0 ft and the piezometer was installed at 35.0 ft. The hole was backfilled with Ottawa sand, then bentonite then clean sand backfill. The falling head test was performed, followed by installation of the protective cover.

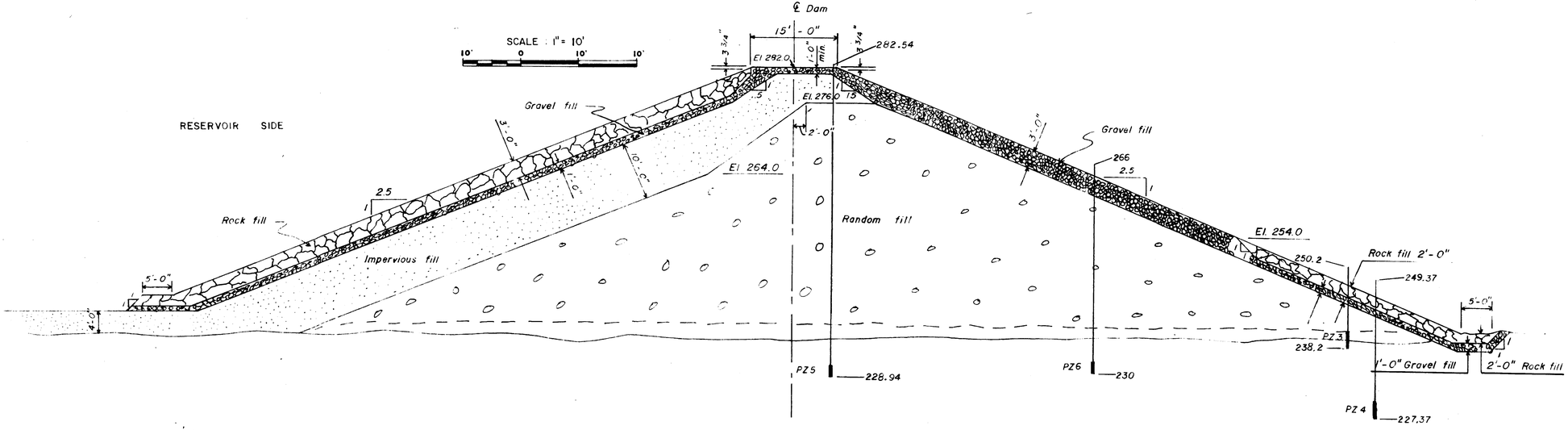
Summary:		
	Drilling	20.0 ft
	Piezometers Installed	1
	Moving/Standby Time	110.0 min

APPENDIX B

Piezometer Installation Logs



PIEZOMETER LOCATIONS STATION 36 + 05.61		
BRIGGS ENGINEERING & TESTING CO. NORWELL, MASSACHUSETTS		
DR. BY: J.C.C.	SCALE: 1" = 10'	PROJ. NO.: 1240B
CK'D BY N.A.L.	DATE: 11/2/81	FIG. NO.: 2



PIEZOMETER LOCATIONS
STATION 34 + 05.61

BRIGGS ENGINEERING & TESTING CO
NORWELL, MASSACHUSETTS

		DRG. NO. 12408
	DATE	NO. 3

APPENDIX C

Survey Field Notes

8059 Richmond Hill — WEST HALL DAM — 7/22/81

PIEZOMETER LOCATIONS

Pz #8 VA 21-00' @ 50' = 53.56

I @ 36+05.61 ECON 42+00 → RT

Pz #1	89-37-30	106.02	VA 21-22'
		98.77	HORZ
Pz #2	92-45-30	105.70	VA 20-47'
I @ 34+05.61		98.82	HORZ
Pz #6	VA 21-00' @ 50' = 53.56		
Pz #3	93-42-00	101.37	VA 21-24'
		94.38	HORZ
Pz #4	93-37-00	105.97	VA = 20-53'
		99.01	HORZ

BM 36+12.61

282.04 ±

2.69 284.69

2.49

GRADE STK for Pz #7 282.20

18.92

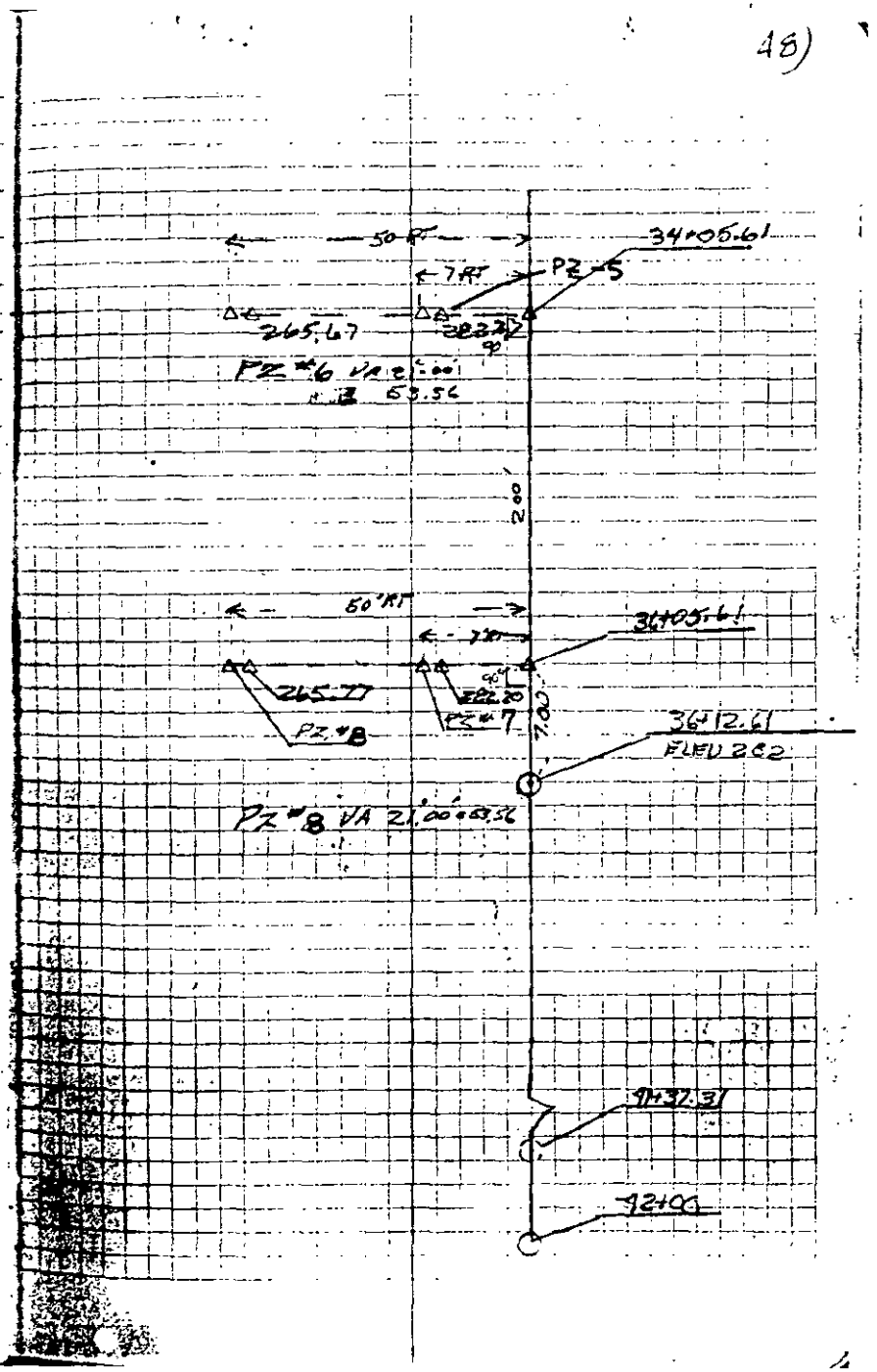
2.21 267.98 265.77 GRADE STK for Pz #8

19.64

TOP PIPE Pz #1 248.34

18.17

TOP PIPE Pz #2 249.51



	26798		
Pz #3	TOP P.V.C.	12.82	250.16
		18.61	
	TOP PVC Pz #4		249.37
	TOP PVC Pz #6	2.31	265.67
	18.24 28391		
		1.54	
	TOP CASING Pz #5		282.37
		1.90	28201

West Hill Dam 8-11-81

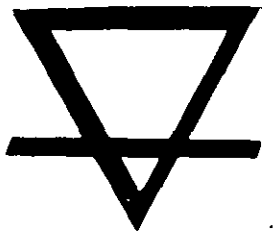
PZ-7 Grade Stake at 282.20
Top of pipe 1.75" above stake

T.O.P 282.20
.15
el 282.35 top of riser pipe

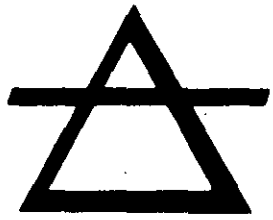
PZ-8A Grade Stake @ 265.77'
Top of Riser pipe 0.99' above stake
el 266.76
top of riser pipe

PZ-5 Grade stake @ 282.37
Top of pipe 0.17' above stake
282.54'

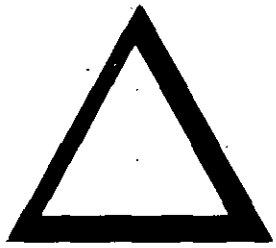
PZ-6 Grade Stake @ 265.67
Top of Pipe 0.33' above stake
@ 266.00' top of riser pipe



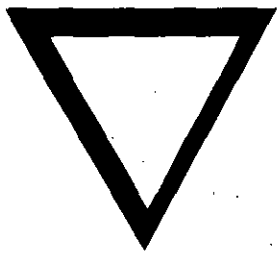
EARTH



AIR



FIRE



WATER

In ancient times
Greek and Hindu philosophers
believed that there were
four elements in the material universe
— EARTH, AIR, FIRE and WATER.
Over the years
man's knowledge has expanded
and the world of materials
is now known to be extremely complex.
The unravelling of these complexities
is the continuing goal of
Briggs Engineering & Testing Company.

BRIGGS

Engineering and Testing

164 Washington Street, Norwell, Massachusetts 02061 Telephone (617) 773-2780